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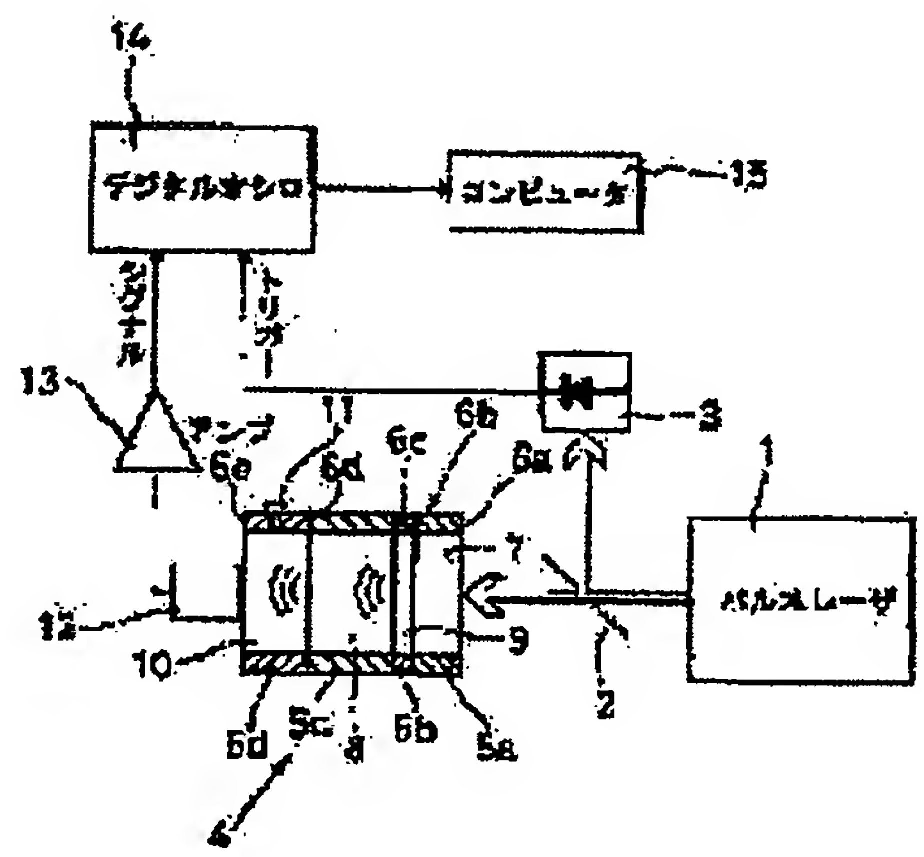
(71)Applicant : HITACHI LTD
(72)Inventor : SONEHARA TSUYOSHI
OZAWA OSAMU
MASUZAWA YUTAKA
FUJII TOSHIKO
KAN MASAO
MIYAHARA YUJI

(54) METHOD AND EQUIPMENT FOR OPTOACOUSTIC ANALYSIS

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a small and highly accurate optoacoustic analyzer and analyzing method.
SOLUTION: An acoustic impedance matching layer 8 transparent for the light from a light source 1 is interposed between a reference sample 9 and a measuring sample 10 and only one acoustic sensor 12 is disposed while touching the measuring sample 10. A pulse light from the light source 1 is passed simultaneously through the reference sample 9, acoustic impedance matching layer 8 and measuring sample 10. Sound waves from the reference sample 9 and measuring sample 10 are detected using one acoustic sensor 12 while being separated on the time axis.



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* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] By the test portion, either combines acoustically the both sides of a transparent acoustic-impedance adjustment layer with this acoustic-impedance adjustment layer, and arranges the 1st sample and 2nd sample whose another side is a reference sample. Incidence of the pulsed light is carried out so that said 1st sample, an acoustic-impedance adjustment layer, and the 2nd sample may be penetrated. The optical sonagraphy approach characterized by dissociating in time and detecting the 2nd acoustic wave generated from the 1st acoustic wave which occurred from said 1st sample and has spread the inside of said impedance matching layer and the 2nd sample, and said 2nd sample with one acoustic sensor.

[Claim 2] The optical sonagraphy approach characterized by to dissociate in time and to detect the 2nd acoustic wave which irradiated pulsed light at the test portion through the acoustic-impedance adjustment layer which combined with the reference sample and this reference sample acoustically, and has been arranged, occurred from the 1st acoustic wave generated from said reference sample, and said test portion, and has spread the inside of said acoustic-impedance adjustment layer with one acoustic sensor.

[Claim 3] The optical sonagraphy approach according to claim 1 or 2 characterized by asking for the ratio of the detecting signal of said 1st acoustic wave, and the detecting signal of the 2nd acoustic wave.

[Claim 4] Optical sonagraphy equipment characterized by the pulsed light which was equipped with a transparent acoustic-impedance adjustment layer and only one acoustic sensor to the light of said light source arranged between the light source which injects pulsed light, a reference sample, a test portion, and said reference sample and test portion, and was injected from said light source penetrating said reference sample, an acoustic-impedance adjustment layer, and a test portion.

[Claim 5] As opposed to the light of said light source arranged between the light source which injects pulsed light, a reference sample, a test portion, and said reference sample and test portion The 1st transparent acoustic-impedance adjustment layer, As opposed to the light of said light source prepared at least in one side of the side which is not in contact with said 1st acoustic-impedance adjustment layer of said reference sample the side which is not in contact with said 1st acoustic-impedance adjustment layer of said test portion The 2nd transparent acoustic-impedance adjustment layer, Optical sonagraphy equipment characterized by the pulsed light which was equipped only with one acoustic sensor and injected from said light source penetrating the said reference sample and said test portion, said 1st, and 2nd acoustic-impedance adjustment layers.

[Claim 6] Said acoustic sensor touches through either said test portion or a reference sample direct, or an interlayer. Said acoustic-impedance adjustment layer has sufficient thickness to separate and detect the acoustic wave generated by said reference sample, and the acoustic wave generated in said test portion on a time-axis in said acoustic sensor. Optical sonagraphy equipment according to claim 1 or 2 characterized by having a means to output the intensity ratio of the component originating in the acoustic wave generated by the reference sample among the output signals of said acoustic sensor, and the component originating in the acoustic wave generated in the test portion.

[Claim 7] Optical sonagraphy equipment according to claim 1, 2, or 3 characterized by filling alphad<3 when setting to alpha the absorption coefficient of the reference sample to the light injected from said light source and setting thickness of a reference sample to d.

[Claim 8] Optical sonagraphy equipment of claim 4-7 characterized by using a transparent liquid to the light of said light source inserted by the transparent film to the light of said light source more thinly enough as said acoustic-impedance adjustment layer than the wavelength of the acoustic wave generated according to the optoacoustic effect given in any 1 term.

[Claim 9] Optical sonagraphy equipment of claim 4-7 characterized by using the solid-state which said test portion is a liquid, and is transparent and has an acoustic impedance near said test portion to the light of said light source as said acoustic-impedance adjustment layer given in any 1 term.

[Claim 10] Optical sonagraphy equipment of claim 4-7 characterized by using the vinyl chloride which mixed the

vinyl chloride or the plasticizer as said acoustic-impedance adjustment layer given in any 1 term.
[Claim 11] As opposed to the light source which injects pulsed light, a reference sample, and the light of said light source A transparent acoustic-impedance adjustment layer, Have only one acoustic sensor and said acoustic sensor is arranged at said one acoustic-impedance adjustment layer side. Said one acoustic-impedance adjustment layer side is a field in contact with a test portion. The pulsed light which said acoustic sensor has been arranged in the opposite side of the field in contact with said test portion of said acoustic-impedance adjustment layer, and was injected from said light source is optical sonagraphy equipment characterized by a test portion irradiating through an acoustic-impedance adjustment layer from said reference sample side.
[Claim 12] Optical sonagraphy equipment given in claim 11 term characterized by using the vinyl chloride which mixed the vinyl chloride or the plasticizer as said acoustic-impedance adjustment layer.
[Claim 13] Optical sonagraphy equipment according to claim 11 or 12 characterized by filling D>2 V/alpha v when setting [the absorption coefficient of said reference sample to the light injected from the light source / the acoustic velocity in alpha and said reference sample] acoustic velocity in D and said acoustic-impedance adjustment layer to V for the thickness of v and said impedance matching layer.
[Claim 14] It is optical sonagraphy equipment according to claim 11, 12, or 13 which said reference sample is water, a glucose water solution, or a physiological saline, and said light source is a pulse laser which injects a high near-infrared light of living body permeability, and is characterized by said acoustic sensor being the acoustic sensor or the transparent sound sensor of a hole vacancy by which the hole is prepared in accordance with the optical path.
[Claim 15] It has the photodetector which detects a part of pulsed light injected from said light source, and the wave storage which has a trigger function. The output signal of said photodetector is inputted into the trigger input of said wave storage. The output of said acoustic sensor is inputted into the signal input of said wave storage. Optical sonagraphy equipment of claim 4-13 characterized by asking for the ratio of the peak Thu peak value of the component originating in the acoustic wave generated by the reference sample among the output signals of said acoustic sensor, and the component originating in the acoustic wave generated in the test portion given in any 1 term.
[Claim 16] It has the peaking capacity circuit which is two into which the output of said acoustic sensor is inputted through two time gate circuits where the time amount section to open shifted from the photodetector which detects a part of pulsed light injected from said light source. The output signal of said photodetector is inputted into the trigger input of said time gate circuit, and the reset input of said peaking capacity circuit. Carry out time sharing of the output of said acoustic sensor, and the peak Thu peak value in each time amount section is calculated. Optical sonagraphy equipment of claim 4-13 characterized by asking for the ratio of the peak Thu peak value of the component originating in the acoustic wave generated by the reference sample among the output signals of said acoustic sensor, and the component originating in the acoustic wave generated in the test portion given in any 1 term.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical sonagraphy approach and the optical sonagraphy equipment which used the source of pulsed light.
[0002]
[Description of the Prior Art] Optical sonagraphy equipment is equipment which analyzes a sample by detecting the acoustic wave generated in case the molecule excited by absorbing carries out non-radiated deactivation of the light. In conventional optical sonagraphy equipment Analytical Chemistry, In order to compensate fluctuation of the reinforcement of the light source etc. as indicated by 53 (1981) 539-540th page [Analytical Chemistly, vol.53 (1981), and pp.539-540] The method of taking the ratio of the reinforcement of the optical acoustic signal detected with the acoustic sensor which the cel into which the light injected from the light source was divided into the 2 flux of lights, and the reference sample went, and the cel containing a test portion passed, respectively, and was made to carry out incidence and was installed in each cel was common.
[0003]
[Problem(s) to be Solved by the Invention] However, when the location which a beam of light injects in the injection section of the light source swings, since the effects the 2 flux of lights divided by the half mirror etc. are influenced differ by the reflected light and the transmitted light, they cannot compensate this with the above-mentioned approach. And since two cels and two acoustic sensors are needed and these are in another location spatially, if fluctuation of uneven temperature arises in a measurement environment, the effect becomes what is different about each, and this also induces a measurement error. If it is going to remove such an error, a large-scale facility of putting the whole system of measurement into one thermostat is needed. Moreover, even if it arranges two acoustic sensors to which the property was [how] equal, dispersion may arise by degradation etc. in the long run. When amplifier is furthermore connected to an acoustic sensor, since fluctuation of the gain of amplifier is also independent between two amplifier, it becomes a cause with error. If fluctuation of 5% or more of big light source reinforcement is only amended, these faults will not pose a problem so much, but if it is going to carry out the quantum of the blood glucose concentration of a normal range from a change of an optical acoustic signal on the strength, at least 0.1% or more of accuracy of measurement is required, and cannot disregard the above-mentioned trouble any longer, for example. The purpose of this invention solves the above-mentioned problem, and is to offer the highly precise and small optical sonagraphy approach and optical sonagraphy equipment.
[0004]
[Means for Solving the Problem] In this invention, by the test portion, either combines acoustically the both sides of a transparent acoustic-impedance adjustment layer with this acoustic-impedance adjustment layer, and arranges the 1st sample and 2nd sample whose another side is a reference sample. Incidence of the pulsed light is carried out so that light may penetrate in order of the 1st sample, an acoustic-impedance adjustment layer, and the 2nd sample. Said purpose is attained by dissociating in time and detecting the 2nd acoustic wave generated from the 1st acoustic wave and 2nd sample which occurred from the 1st sample and have spread the inside of an impedance matching layer and the 2nd sample with one acoustic sensor.
[0005] Moreover, said purpose is attained by dissociating in time and detecting the 2nd acoustic wave which irradiated pulsed light at the test portion through the acoustic-impedance adjustment layer which combined with the reference sample and this reference sample acoustically in this invention, and has been arranged, occurred from the 1st acoustic wave and test portion which were generated from the reference sample, and has spread the inside of an acoustic-impedance adjustment layer with one acoustic sensor.
[0006] An acoustic-impedance adjustment layer has sufficient thickness to separate and detect the acoustic wave generated by the reference sample, and the acoustic wave generated in the test portion on a time-axis in

one acoustic sensor. By asking for the intensity ratio of the component originating in the acoustic wave generated by the reference sample among the output signals of an acoustic sensor, and the component originating in the acoustic wave generated in the test portion Fluctuation of fluctuation of light source reinforcement, fluctuation of the location of the flux of light, the sensibility of an acoustic sensor, and the gain of amplifier is compensated, and very highly precise optical sonagraphy can be performed.

[0007] The optical sonagraphy equipment by this invention is equipped with a transparent acoustic-impedance adjustment layer and only one acoustic sensor to the light of the light source arranged between the light source which injects pulsed light, a reference sample, a test portion, and a reference sample and a test portion, and is characterized by the pulsed light injected from the light source penetrating a reference sample, an acoustic-impedance adjustment layer, and a test portion. Other acoustic-impedance adjustment layers are arranged at least to one side of the side which is not in contact with the acoustic-impedance adjustment layer of a test portion or a reference sample, and you may make it prevent reflection of an acoustic wave.

[0008] Solid-states, such as a vinyl chloride which mixed the transparent liquid inserted by the transparent film to the light of said light source more thinly enough as an acoustic-impedance adjustment layer than the wavelength of the acoustic wave generated according to the optoacoustic effect, the vinyl chloride, or the plasticizer, can be used. Moreover, the light source to which the optical sonagraphy equipment by this invention injects pulsed light, As opposed to a reference sample and the light of the light source A transparent acoustic-impedance adjustment layer, Have only one acoustic sensor and an acoustic sensor is arranged at one acoustic-impedance adjustment layer side. One of the acoustic-impedance adjustment layer side is a field in contact with a test portion. An acoustic sensor is arranged in the opposite side of the field in contact with the test portion of an acoustic-impedance adjustment layer, and pulsed light injected from the light source is characterized by a test portion irradiating through an acoustic-impedance adjustment layer from a reference sample side.

[0009]

[Embodiment of the Invention] Hereafter, this invention is explained to a detail using a drawing.

[Gestalt 1 of operation] Drawing 1 is the conceptual diagram showing the gestalt of operation of the 1st of this invention. the optical sound cel 4 shows a cross section to drawing 1 , and shows a perspective view to drawing 2 -- as -- for example, the thin films 6b, 6c, and 6d transparent among four spacers 5a-5d of a cylindrical shape -- liquid -- it inserts densely and piles up, and the transparent thin films 6a and 6e are stuck on a Spacers [5a and 5d] end face, and it is constituted. The acoustic sensor 12 is joined to thin film 6e. A transparent thing is chosen to the light to which the light source 1 outputs the quality of the material of thin films 6a-6e, for example, a polyethylene film is used if the output of the light source 1 is the light or near-infrared light. The transparent liquids 7 and 8 are held in the building envelope of spacer 5a inserted with thin films 6a and 6b, and the building envelope of spacer 5c inserted with thin films 6c and 6d to the light which the light source 1 outputs respectively. The reference sample 9 is held in the building envelope of spacer 5b inserted with thin films 6b and 6c, and the test portion 10 is held in the spacer 5d building envelope across which it faced with thin films 6d and 6e. A test portion 10 opens a plug 11, and is poured in or discharged in the optical sound cel 4.

[0010] The liquid 7 divided with thin films 6a and 6b and the liquid 8 divided with thin films 6c and 6d form the acoustic-impedance adjustment layer to the reference sample 9 and a test portion 10. The thickness of thin films 6a-6e is set up sufficiently small as compared with the wavelength of the acoustic wave pulse generated by the test portion 10 and the reference sample 9. That to which the acoustic impedance resembled the test portion 10 closely is used for the liquids 7 and 8 and the reference sample 9 which form an acoustic-impedance adjustment layer. The absorption-of-light property of the reference sample 9 must also be close to a test portion 10.

[0011] The light source 1 is a pulse laser which outputs the light of the wavelength which a test portion absorbs. A part of pulsed light of the light source 1 is divided by the beam splitter 2, incidence is carried out to a photodetector 3, and the output signal of a photodetector 3 is made into the trigger signal of the digitizing oscilloscope 14 of two or more channels. That in which build up time has the speed of response which can regard the output of a pulse laser 1 as a pulse is used for a photodetector 3.

[0012] Since the rate of light is quick enough, it can be considered that the light which carried out incidence to the optical sound cel 4 reaches a test portion 10 and the reference sample 9 at coincidence. The acoustic wave pulse which the acoustic wave pulse generated in the test portion 10 was first detected with the acoustic sensor 12 (the 1st pulse), and generated by the reference sample 9 continuously spreads through the acoustic-impedance adjustment layer (1st acoustic-impedance adjustment layer) and test portion 10 which consisted of liquid 8 grades, and is detected by the acoustic sensor 12 (the 2nd pulse). In order to prevent the reflection in the field where thin film 6b touches the reference sample 9, the acoustic-impedance adjustment layer (2nd impedance matching layer) which consisted of liquid 7 grades at the optical incidence side of the reference sample 9 is prepared. Since thin films [6c and 6d] thickness is fully thin, the time delay between the 1st pulse

and the 2nd pulse is given by [(thickness of the acoustic-impedance adjustment layer 8) / (acoustic velocity in the acoustic-impedance adjustment layer 8)]. In addition, although the acoustic sensor 12 is in contact with the test portion 10 through thin film 6e in drawing 1 , the acoustic sensor 12 may be in contact with the direct measurement sample.

[0013] Thus, although the signal with which two pulses separated in time stood in a row is acquired from the sound sensor 12 Amplify this with amplifier 13 and it saves by making the output signal of a photodetector 3 into a trigger signal at a digitizing oscilloscope 14. The saved wave is downloaded to a computer 15, the peak Thu peak value Vpp1 of the 1st pulse and the peak Thu peak value Vpp2 of the 2nd pulse are calculated, and the ratios Vpp1/Vpp2 are calculated further.

[0014] The purpose detection component was made into blood glucose concentration, as a blood serum and a reference sample 9, as liquids 7 and 8 for pure water and the acoustic-impedance adjustment stratification, the polyethylene film was used as heavy water and thin films 6a-6e, and the glass pipe was used as spacers 5a-5d as a test portion 10 in this example. Moreover, as a photodetector 3, the indium gallium and the arsenic semi-conductor photodiode were used using the optical-parametric-oscillator laser which outputs 1560nm which is the absorption wavelength in near-infrared [of a glucose] as the light source 1.

[0015] Pulse duration is [the peaking capacity of the pulse laser used as the light source 1] about one MW for 6ns. Build up time is 0.3ns and the photodiode used for the photodetector 3 can reproduce almost faithfully the pulse shape of the output light of the light source 1. Since the peaking capacity of laser is very high, the quantity of light included in a photodetector 3 comes out [the output of the light source 1 / in part] very much and is good. Then, as a beam splitter 2, the reflection factor used the glass substrate which gave the antireflection film which is 0.5% to both sides. Since about 1 ppm of the total quantity of light of the quantity of light which carries out incidence to a photodetector 3 are enough, it may detect the light scattered about on the optical sound cel front face etc. not using a beam splitter, and may generate a trigger output.

[0016] When thickness of alpha and a reference sample is set to d for the absorption coefficient of the reference sample 9 to the light injected from the light source 1, in order for the light injected from the light source 1 to reach to a test portion 10 efficiently, it is desirable to fill a degree type.

alphad<3[0017] When thickness of spacer 5b is thickened too much, light stops coming to a test portion 10 in this example, since there is a 7cm - 1 about absorption coefficient to the light of the light source 1 of the reference sample 9. For example, if thickness of spacer 5b is set to 10mm, the quantity of light which carries out incidence to a test portion 10 will become 1/1000 of the quantity of lights which carry out incidence to the reference sample 9. It was made for the abbreviation one half of the amount of incident light to reach a test portion 10 here by setting thickness of spacer 5b, i.e., the optical path length in the reference sample 9, to 1mm. Moreover, by setting the optical path length in the spacer 5d thickness 10, i.e., a test portion, to 10mm, the quantity of light which penetrates a test portion 10 is 1/1000 of the quantity of lights which carry out incidence to a test portion, and generating of the acoustic wave by the transmitted light being absorbed by the direct sound sensor 12 is prevented.

[0018] Drawing 3 is drawing of the signal wave form which observed the output signal of an acoustic sensor 12 with the digitizing oscilloscope 14, and was acquired, when it measures by making a diabetic's blood serum into a test portion using the equipment shown in drawing 1 . The peak Thu peak value Vpp1 of the 1st pulse originates in a test portion, and the peak Thu peak value Vpp2 of the 2nd pulse originates in a reference sample. About the optical path length in the reference sample 9, since 1mm and the acoustic-impedance adjustment layer 8 were used as the layer which consists of heavy water (sonic about 1.4 km/s) with a thickness of 2mm, the time delay between the 1st pulse and the 2nd pulse is about 1.4 microseconds.

[0019] Drawing 4 is drawing showing time amount change of Vpp1 and Vpp2 of an optical acoustic signal which carried out in this way and was measured. Moreover, drawing 5 is drawing showing time amount change of the ratio of Vpp1 and Vpp2 of an optical acoustic signal. Although the reinforcement of an optical acoustic signal itself is swinging greatly in time by fluctuation of laser reinforcement etc. so that clearly if drawing 4 is compared with drawing 5 , fluctuation is reduced by 1/5 or less by taking the ratio of Vpp1 and Vpp2.

[0020] Although the count of addition per point was made into 64 times here, it is possible by increasing the count of addition to decrease fluctuation further. Although the repetition rate of a pulse laser was carried out in 10 times/s, even if it uses the laser whose repetition rate is 1000 times/s, the same measurement is possible for it, and it can raise the accuracy of measurement 10 times by the same measuring time in that case. Other pulse lasers which output the light of the same wavelength may be used for the light source 1, and the pulse laser of the absorption wavelength of glucoses other than 1560nm, for example, the wavelength near 2280nm, may be used for it. Moreover, what is necessary is just to use the pulse laser of the wavelength of the absorption band of a proper for the component, in order to carry out the quantum of the constituents of blood other than a glucose.

[0021] According to the gestalt of this operation, fluctuation of light source reinforcement can be compensated by taking the ratio of the peak Thu peak value of two detection pulses. Moreover, the fluctuation of the sensibility of the acoustic sensor itself and the gain fluctuation of amplifier which were not able to be compensated can also be compensated with conventional 2 flux-of-light light sonagraphy equipment almost completely, and fluctuation of the location of incoming beams can also be compensated to some extent with it. And the number of an acoustic sensor or amplifier can be reduced by half compared with a conventional method.

[0022] [Gestalt 2 of operation] Drawing 6 is the conceptual diagram showing the gestalt of operation of the 2nd of this invention. The gestalt of this 2nd operation constitutes the noninvasive-measurement equipment of blood glucose concentration by making into a test portion blood which flows a living body's 30 blood vessel 31. The same optical-parametric-oscillator laser as having used it with the gestalt of the 1st operation as the light source 21 was used. Most beams of light injected from the pulse laser light source 21 penetrate a beam splitter 22, and it carries out incidence to the optical sound sensor 24, and it is reflected by the beam splitter 22 and incidence of the remaining beam of light is carried out to a photodiode 23.

[0023] The optical sound sensor 24 is equipped with the acoustic sensor 25 which becomes a part for the core which an incident ray passes from PZT which the hole 26 opened, and the solid acoustic-impedance adjustment layer 29, as a cross section is shown in drawing 6 and a perspective view is shown in drawing 7 . Generating of the acoustic wave by setting the path of the hole 26 of 3mm and an acoustic sensor 25 as 5mm, and acoustic-sensor 25 self carrying out direct light absorption of the beam diameter of the laser beam which carries out incidence was prevented completely. The polyvinyl chloride containing a plasticizer was used as a solid acoustic-impedance adjustment layer 29, the crevice was established in the side of one of these, the physiological saline was held as a reference sample 28, and the front face was sealed with the cover glass 27. Without irradiating an acoustic sensor 25, the beam of light from the light source 21 which carries out incidence to the optical sound sensor 24 penetrates the reference sample 28 through the hole 26 established in the core, penetrates the inside of the acoustic-impedance adjustment layer 29 continuously, and is irradiated by the blood vessel 31 in a living body 30.

[0024] The measuring object is used as a diabetic's arm and the optical sound sensor 24 to a measurement part is contacted with the wristband made of rubber (not shown) fixed to the acoustic-impedance adjustment layer 29. The optical path length in 1mm and the acoustic-impedance adjustment layer 29 is set to 10mm for the optical path length in the reference sample 28. By forcing strongly the field of the acoustic-impedance adjustment layer 29 of the side which is not in contact with an acoustic sensor 25 into the part which whose blood vessel 31 of an arm 30 is transparent, and is visible It is made for the acoustic wave generated through the blood vessel 31 to transmit to the acoustic-impedance adjustment layer 29 almost directly, and it prevents mixing of the acoustic wave signal generated in body tissues other than blood vessel 31. A measurement part is good anywhere, if not only an arm but a blood vessel is the part of epidermis to which it exists in near comparatively and is easy to stick the optical sound sensor 24.

[0025] Although the acoustic sensor 25 of the optical sound sensor 24 detects the signal which consists of a series of two pulses almost same with being shown in drawing 3 By having made the same the field as for which light carries out incidence, and the field which detects an acoustic wave using the acoustic sensor 25 of a hole vacancy, the detection sequence of the signal by the acoustic wave generated by the reference sample 28 and the signal by the acoustic wave generated in the test portion (in this case, blood which flows the inside of a blood vessel 31) becomes reverse.

[0026] In order to separate clearly the acoustic wave pulse generated by the reference sample 28, and the acoustic wave pulse generated in the test portion on a time-axis, when setting [the absorption coefficient of the reference sample to the light injected from the light source 21] the thickness and acoustic velocity of v and the impedance matching layer 29 to D and V for the acoustic velocity in alpha and a reference sample, respectively, it is required to fill the following relation.

D>2V/alphav [0027] Considering viewpoints, such as attenuation of the acoustic wave in the acoustic-impedance adjustment layer 29, diffusion and a miniaturization of equipment, and saving of a material, as small the one of thickness D of the acoustic-impedance adjustment layer 29 as possible is good. When using a physiological saline as a reference sample, it is v=1500 m/s and alpha=7cm-1. Here, the vinyl chloride containing a plasticizer was used as an acoustic-impedance adjustment layer 29, and V was adjusted to 2500 m/s smaller than the acoustic velocity in the usual polyvinyl chloride. Therefore, if it is D> 5mm, the above-mentioned conditions will be fulfilled. Since thickness D is set to 10mm in fact, the signal by the acoustic wave generated by the reference sample and the signal by the acoustic wave generated in the test portion (in this case, blood in a blood vessel) are clearly separated on a time-axis, and both time delay is set to about 4 microseconds.

[0028] A slide glass 27 is fully thin and the acoustic wave generated by the reference sample 28 reaches the

hole vacancy sound sensor 25 mostly with generating of pulsed light in the time scale of mus at coincidence. Then, the time gate of the after [2.5 microseconds] 0 microsecond after making the output signal of a photodetector 23 into a trigger by time gate circuit 42a is prepared. The peak Thu peak value of the signal by the acoustic wave generated by the reference sample 28 in peaking capacity circuit 43a is calculated. The time gate of the after [5.0 microseconds] 2.5 microseconds after making the output signal of a photodetector 23 into a trigger by time gate circuit 42b is prepared. The peak Thu peak value of the signal by the acoustic wave generated through the blood vessel 31 in peaking capacity circuit 43b is calculated, and each is changed into digital value by AD converters 44a and 44b, and it asks for a ratio by computer 45. The output of a photodetector 23 is inputted into the reset input of the peaking capacity circuits 43a and 43b while it is inputted into the trigger input of the time gate circuits 42a and 42b.

[0029] Drawing 8 is a graph showing the relation as a result of the both sides when measuring the ratios Vpp1/Vpp2 of peak Thu peak value for every fixed time amount, collecting blood from a patient to coincidence, and measuring blood glucose concentration by the enzyme reaction, giving a carbohydrate tolerance test to the diabetic who is the measuring object. It turns out that ratios Vpp1/Vpp2 show blood glucose concentration and high correlation, and the quantum of the latter can be carried out in sufficient precision from the former value.

[0030] The material of the acoustic-impedance adjustment layer 29 may be transparent, and as long as acoustic-impedance adjustment with a living body is a good ingredient, good for example, transparent silicone rubber with few impurities is sufficient as it anything. Moreover, although the acoustic sensor 25 and the reference sample 28 touch through the sufficiently thin cover glass 27, they may use a layer with a thickness of about 1mm it is thin from the same material as what was used for the acoustic-impedance adjustment layer instead of a thin cover glass, or may prevent the leak of the reference sample 28 using an O ring etc., and may contact an acoustic sensor 13 and the reference sample 7 directly. The transparent sound sensor by which coating of the transparent electrode was carried out may be used for an acoustic sensor. A quartz resonator can be used as a transparent sound sensor.

[0031] While the same effectiveness as the gestalt of the 1st operation is acquired according to the gestalt of this operation, an acoustic wave is efficiently detectable by having used the hole vacancy sound sensor through an acoustic-impedance adjustment layer with it being uneven like a living body and uniform from the field where the difficult sample also irradiated light detecting an acoustic wave in the opposite side of the field which irradiated light, and a reference sample. Moreover, by having unified the acoustic-impedance adjustment layer in solid form, the good contact to long-term stability and the body is acquired, by having substituted for the digitizing oscilloscope the circuit of the dedication which restricted the function, it is cheap and equipment can be made small.

[0032]

[Effect of the Invention] According to this invention, optical sonagraphy equipment highly precise and small, and cheap can be constituted only from one acoustic sensor, and non-invasion hemanalysis equipment can be realized by making the blood vessel in a living body into the measuring object by using this.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The conceptual diagram showing the gestalt of operation of the 1st of this invention.
[Drawing 2] The perspective view of an optical sound cel.
[Drawing 3] Drawing showing an optical acoustic signal.
[Drawing 4] Drawing showing time amount change of the peak Thu peak value of the pulse of an optical acoustic signal.
[Drawing 5] Drawing showing time amount change of the ratio of the peak Thu peak value of two pulses in an optical acoustic signal.
[Drawing 6] The conceptual diagram showing the gestalt of operation of the 2nd of this invention.
[Drawing 7] The perspective view of a sensor.
[Drawing 8] Drawing showing the ratio of the peak Thu peak value of two pulses of an optical acoustic signal, and the relation of blood glucose concentration.
[Description of Notations]
1 [-- Optical sound cel.] -- The light source, 2 -- A beam splitter, 3 -- A photodetector, 4 5a-5d -- A spacer, 6a-6e -- 7 A transparence thin film, 8 -- Transparence liquid, 9 [-- An acoustic sensor, 13 / -- Amplifier,] -- A reference sample, 10 -- A test portion, 11 -- A plug, 12 14 -- A DEJITAISHINGU oscilloscope, 15 -- A computer, 21 -- Light source, 22 [-- Hole vacancy sound sensor,] -- A beam splitter, 23 -- A photodetector, 24 -- A sensor, 25 26 [-- An acoustic-impedance adjustment layer 30 / -- A living body, 31 / -- A blood vessel, 41 / -- Amplifier, 42a, 42b / -- A time gate circuit, 43a, 43b / -- A peaking capacity circuit, 44a, 44b / -- An AD converter, 45 / -- Computer] -- A hole, 27 -- A cover glass, 28 -- A reference sample, 29

[Translation done.]